University College Dublin

SLM 3D printing for Moulds

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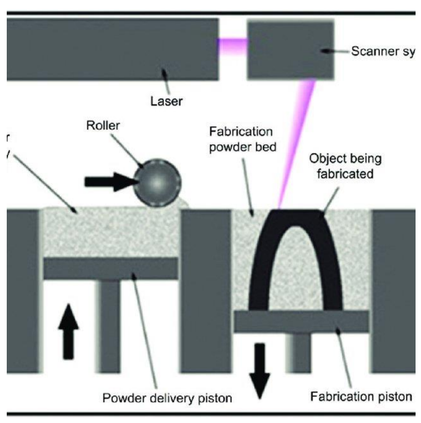
Introduction:

For this project, selective laser melting (SLM) was used to 3D print stainless steel powder to make very small and accurate moulds for plastic inserts. The objective of the project, at this time, is to 3D print micro features in the form of ridges on a base plate with accuracy. Currently, the main objective is perfecting the 3D printing and post-printed polishing processes to make sure that ridges can be made small enough and accurate enough to be used as a mould later on. To accomplish this, I am focusing on surface roughness and internal porosity of the 3D printed ridges.

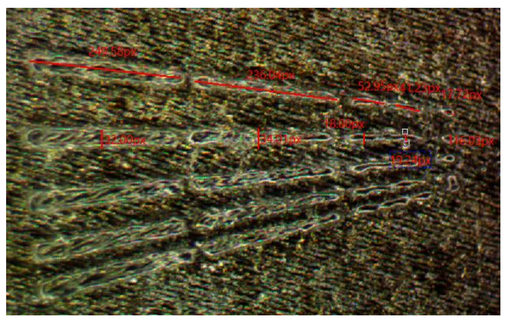
How Selective Laser Melting Works:

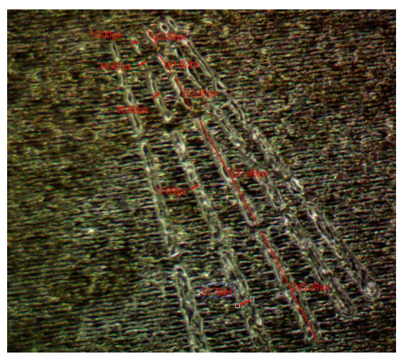


Selective laser melting (SLM) uses a focused laser to melt metal powders into a shape. In this case, a special SLM machine was used to make stainless steel ridges, which will then be analyzed and treated to be as smooth and accurate as possible. These ridges give us an idea for what is possible when it comes to making future moulds.

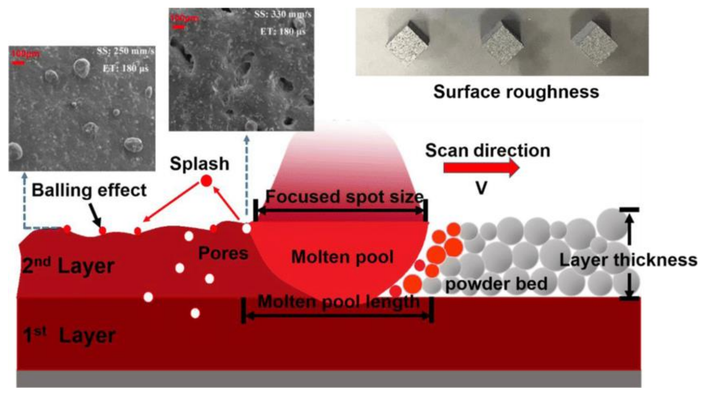
Previous Progress:

Before My arrival to this project, the team tried to 3D print ridges in the range of roughly 50 microns. By the end of the semester, they realized that was a very ambitious goal, and the ridges at this size were far too small to be polished and later used for moulds.





Issues with Selective Laser Melting:

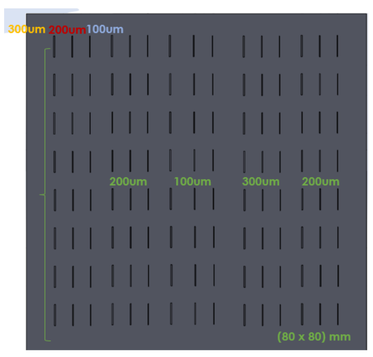


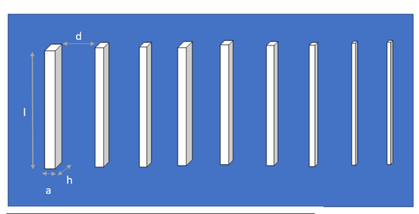
Some common Issues associated with the Selective Laser Meting phase include:

- Planarity: The surfaces aren't flat enough
- Lack of fusion with other particles or already formed stainless steel around it
- Inadequate porosity: The stainless steel has air pockets or not-melted powder within that compromise the ridge's overall internal stability
- Partially melted stainless steel particles
- Balling (pictured left)
- Spatter Particles (pictured left)

Progress so Far:

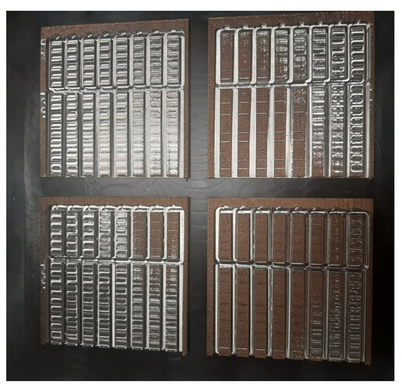
The first step was to create a CAD model of ridges to be SLM printed. This is the CAD model used, along with the range of sizes chosen:





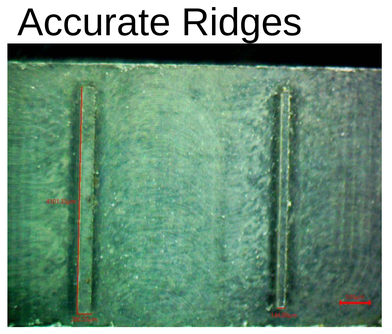
a (um)	h (um)
300	300, 200, 100
200	300, 200, 100
100	300, 200, 100

The ridges were then printed at WIT using the SLM technique. The samples then had to be separated from the build plate and half of them were machined:

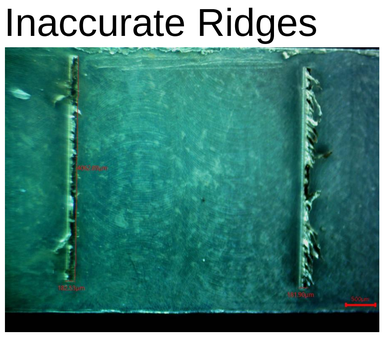


These were then cut into smaller pieces so they could be analyzed manually by looking at them under the microscope. Computer software will later be to get more accurate measurements of surface roughness. Here are some of the images of the ridges under a microscope:

Accurate Ridges



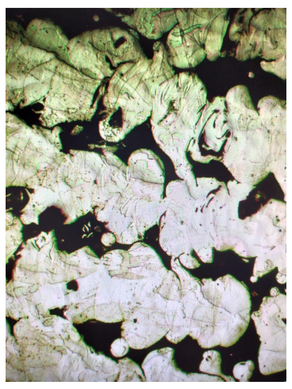
Inaccurate Ridges



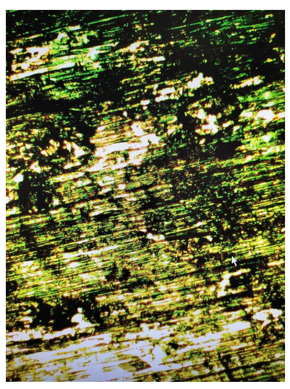
These samples were then made into moulds, which will be sanded and polished down to further analyze surface roughness and internal porosity. The aforementioned computer program can also be used at this stage, or the sample can be analyzed under the fancy microscope pictured below.

Here are some examples of Stainless steel under this microscope. To the left is an example of "regular" stainless steel, and on the right is 3D printed stainless steel using powders.

"Regular" Stainless Steel



3D Printed Stainless Steel



Moving Forward with the Project:

After analyzing the surface roughness and porosity, one of the other teammates will be experimenting with different methods of electro-polishing the samples. This information will provide the best ways to make the most accurate ridges for the next round of analyzing. After repeating this process enough times, the ridges will be made accurate enough for a plastic mould such as the one pictured to the right.